



# AgConnections

## AGRICULTURAL SAFETY AND HEALTH

Vol. 1, No. 3

NIOSH Agricultural Research Centers Update for Summer, 2003

### Partner Initiatives For Tractor Safety

*Note: NIOSH convened representative stakeholders and the Agricultural Centers to discuss efforts and challenges involved to reduce tractor injuries and to begin a collaborative process to develop a long-term national action plan for tractor safety.*

NIOSH internal research projects are exploring 1) development of a deplorable ROPS capable of responding to signals within 0.3 seconds, 2) ROPS made from fiberglass composite materials to reduce cost, 3) adequacy of latest ROPS standards.

VA Farm Bureau implemented a tractor overturn and ROPS education program coupled with a ROPS installation incentive (\$150) to offset member's cost. Participants also receive a slope degree indicator. Since 1994, 159 ROPS have been installed under this program at an average cost of \$683. There is some concern about the wide variation in cost between dealers for retro-fitting the same ROPS.

The Association of Equipment Manufacturers have reported that tractor makers have voluntarily made ROPS standard equipment since 1985. Other design features receiving attention include operator controls, driveline guarding, operator presence systems, lighting and marking, as well as access/egress safety. The association has identified research opportunities including safety issues for "hobby farmers".

FEMCO is a manufacturer of ROPS.

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A century-old problem started in 1914 when M. Hartsough manufactured a small tricycle tractor, the Little Bull, driven by the larger of two rear wheels. It marked the beginning of farm tractors powered by internal combustion engines; amid growing demand and excitement over these small workhorses, tragedy struck! These tractors had a propensity to overturn when the drive wheel was on the downhill side while traversing slopes. It crushed many of its operators.

As tractors displaced animal power on the farm by mid-century, the toll of tractor overturn-related deaths approached 500 per year in the United States. By the late 1950's, rollover protective structures (ROPS) had been developed to shield the operator from crushing injuries in the event of an overturn, and where used, ROPS have virtually eliminated overturn-related deaths.

By the late 1960's, manufacturers were designing ROPS for tractors, but they did not become standard equipment until 1985. Nonetheless, half of the farm tractors in use today lack a ROPS, and we still experience more than 200 overturn-related fatalities per year.

As we enter the current century, the tractor is the single largest cause of work-related death on the farm. In addition, tractor runovers, collisions, and entanglements cause terrible injuries, and many of them are fatal. Furthermore, farm youth are exposed to these dangers. Tractor-related injury is a national problem, and thus, NIOSH has launched an effort to engage the Agricultural Research Centers and the National Children's Center for Rural and Agricultural Health and Safety in a common mission: to reduce death and injury associated with the use of the farm tractor.

Toward this mission, NIOSH convened a Tractor-Related Fatality and Injury Workshop on February 13-14, 2003. This workshop included Centers' staff, safety professionals, representatives

of tractor and ROPS manufacturers, government officials, and business representatives. Following the Workshop, the Center Directors convened to develop priorities and plans to prevent tractor-related injuries.

The development of these plans is underway, and includes broad based input.

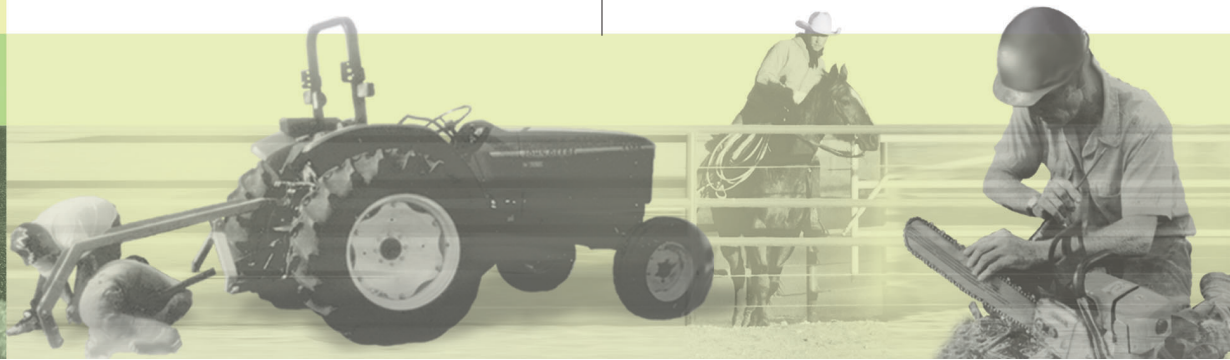
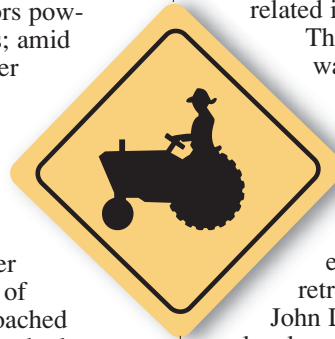
For example, concerted manufacturer action has proven effective.

Tractor manufacturers made ROPS standard equipment in 1985. In the early 1990's, they mounted a unified program that encouraged dealers and farmers to retrofit older tractors with ROPS. One John Deere dealer followed through with a local campaign that increased annual retrofit rates seven-fold, yet the concerted campaign by all manufacturers has waned, and along with it dealer attention to retrofits has waned as well.

Reducing the cost of retrofits is also important. NIOSH is exploring alternative designs to reduce these costs, but other approaches were raised at the Workshop such as putting cost-reducing competition to work. To allow broader competition, there is a need for ROPS-retrofit design standards and for harmonization between different ROPS consensus standards.

Priorities are needed in several areas to reduce the injuries and deaths related to tractors including community partnerships and policy development as well as new technology, public education, incentives, and epidemiology. Crushing injuries related to overturns is just one tractor-related hazard, but it demonstrates our challenge. At the current tractor replacement rate it will take another 15 years to increase our national inventory of ROPS-equipped tractors from 50% to 75%. The challenge is, "How do we move more quickly in our quest for safer tractors?"

Melvin L. Myers, MPA  
Associate Professor, Emory University  
and the University of Kentucky



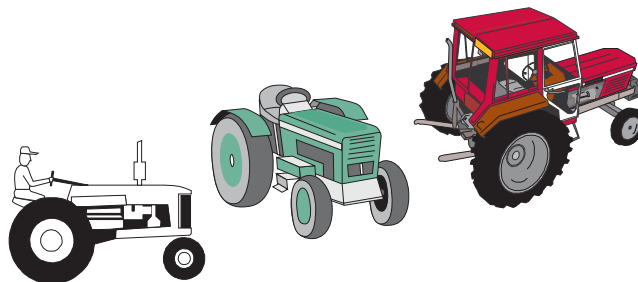
## FRESH FROM THE FIELD

by John J. May, M.D.  
Director Northeast Center

The farm tractor represents a significant hazard for Northeastern farmers. In New York it has consistently accounted for over 50% of all occupational fatalities in farmers. A recent study of serious injury to children on NY farms found that the tractor was involved in 24% of child fatalities and 19% of all serious injuries. Dennis Murphy's work shows that 50.5% of Pennsylvania farmers die in tractor-related incidents.

Much of the problem relates to the demographics of Northeastern tractors. In the early 1990's, researchers from the New York Center for Agricultural Medicine and Health (NYCAMH) systematically inspected 605 tractors on 136 randomly selected NY dairy farms. Seat belts were absent or clearly never used on over 90%. By-pass starter covers were missing on 70%. Two-thirds had no ROPS and 45% had missing or defective power take off (PTO) master shields. The mean age of these tractors was over 20 years, with greater than 80% of all tractors at least ten years old. Subsequent work in the New York Farm Family Health and Hazard Survey by Eric Hallman and the team from Cornell found ROPS present on 38.6% of tractors with the combination of ROPS and seat belts evident on only 28.1% of tractors. In a mail survey, Penn State researcher Tim Kelsey found a reported 68% of ROPS on tractors manufactured after 1985, with substantially lower rates on tractors manufactured before that date. New York farmers reported to Dr. Kelsey that 51% of their "at risk" field hours were in a tractor equipped with ROPS. Seat belts were said to be used 31% of the time, so Dr. Kelsey estimated that effective protection (seat belt + ROPS) was present 8 – 32% of the at risk time.

Clearly there is a sizable population of older tractors in the Northeast that require retrofitting with ROPS to render them safer. Unfortunately this is a costly procedure that requires considerable "buy in" from the farmer – both figuratively and literally. When questioned by Dr. Kelsey, 40% of New York farmers indicated no



interest in retrofits or cabs even if offered for free. Another 11% would consider a retrofit ROPS only if the ROPS and installation were free. Simultaneously, another Northeast Center (NEC) project was exploring this further. Eric Hallman contacted randomly selected New York dairy farmers offering assistance in ROPS retrofitting a tractor of their choice. In some letters the farmers were offered free engineering consultation. In others they were offered reimbursement of some proportion of costs (varying from 10% to 70%) as well as the engineering assistance. In the Hallman study, farmers' interest in retrofits rose as the size of the rebate rose. A majority of farmers accepted the retrofit only when the rebate approached 70%. Individual dealers' charges for installation were a major determinant of the cost of the retrofits.

The NEC is particularly proud of the ongoing work being done at Penn State by Dennis Murphy's team. This project involves use of on-board sensors and microprocessors to detect impending tractor instability and effectively alert the operator in time to prevent an overturn. It is based upon years of effort at modeling the tractor's center of gravity and situations of instability. The challenges involve cost, the problem of rear overturns as well as side overturns, the added complexity of trailed implements and design of an effective warning strategy. To date most NEC tractor projects have mainly defined the serious challenges involved in addressing the tractor problem. With the Penn State instability work, we are hopeful that real progress can be made in reducing this important hazard.

## High School Social Studies Students as Farm Safety Advocates

Henry P. Cole, Ed.D., Southeast Center

Junior and senior high school students participated in a farm community safety project that used the paper and pencil and CD-ROM versions of the *Kayles' Difficult Decisions* simulation exercise. The simulation depicts a farm family over a three-year period as they double their farm production and become short on time, labor and money. The Kayles' become fatigued, stressed and at increased risk of injury. They face difficult decisions involving tradeoffs between making do with present labor and equipment or reducing hazards by hiring part-time help and replacing unsafe equipment. As small groups of students work through the simulation scenario they interact with each other and the story characters' goals, obstacles, and predicaments. The interactive program updates the Kayles' farm economic status as

the scenario develops. The climax occurs when rushing to bring in two crops before it rains the fatigued Kayles take safety shortcuts. Billy, the 14-year old son, is severely injured in a tractor overturn event similar to the real event shown in the photo below. Because of his injury Billy's part-time labor



Photo taken by EMS squad of a fourteen-year-old boy under an overturned tractor

is lost as is his mother's because she has to care for Billy. The medical and lost production costs are huge and threaten the loss of the farm. The simulation increased students' scores on farm safety and economics tests and their understanding of why investing in safety equipment and practices is an effective loss control method. The 156 students were assigned to discuss the Kayles' simulation case and issues with adult farmers in their communities. A month later follow-up telephone interviews were conducted with 55 of these farmers. The students' discussion caused 85% of the farmers to think more about the cost of injury, 70% to consider hiring part-time help during peak seasons, and 60% who reported that they had subsequently acted to remove an injury risk by installing a ROPS on a tractor, an equipment machine guard, or by repairing faulty equipment. Both teachers and students found the simulation to be engaging, relevant to and resonant with their lives, communities, and concerns.



## Tractor Safety Risk Rating

by M. D. Madsen, BSAG, MBA  
Great Plains Center

The Great Plains Center has undertaken eight areas of work since TRAC that address tractor safety. Among them is the Certified Safe Farm (CSF) program, which integrates education and the other core services of health screenings and on-farm safety reviews. The CSF program addresses a spectrum of safety and health risks. Tractor safety is addressed in the safety checklist for the on-farm review. A farm's tractor safety score impacts the farm's ability to become certified. In broader demonstrations of CSF (1998-2002) 152 farms made 224 improvements to tractors and added ROPS to 3% of their non-ROPS tractors.

We are considering an expanded tractor safety evaluation tool that integrates tractor attributes, amount and kind of use, and characteristics of the user. Beyond the obvious considerations like ROPS, which impacts the outcome of an overturn, parameters relating to runovers, road transport collisions, and entanglements are factored into a tractor safety risk rating. Extra riders on equipment for casual purposes without a recommended instructional seat "costs" the farm 30 points. Tractor operation over 5% by a person under age 20 costs 50 points. Incomplete safety recall or modification programs are 50 points each. In addition, we're exploring how more farms can be moved to install ROPS through corrective action planning and making certification renewal contingent upon ROPS installation on all tractors.

## ROPS Design For Older Tractors

by Paul Ayers, PhD., PE  
High Plains Intermountain Center (HICAHS)

Tractor overturns are a leading cause of agricultural fatalities. ROPS are effective in preventing fatalities during rollovers. ROPS are not available for many older tractors. A multi-year project conducted by HI-CAHS addressed the design and testing roll-over protective structures (ROPS) for pre-ROPS agricultural tractors in the United States.



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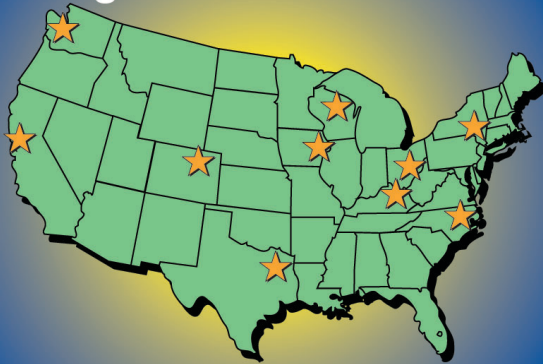
The initial effort included identifying and categorizing pre-ROPS tractors into 4 axle housing categories. A tractor axle-housing category con-

sists of a group of tractor models with similar axle housing dimensions. A representative tractor model for each axle housing group was determined as the Ford 8N, John Deere A, Farmall M and Allis Chalmers D17. ROPS were then designed, constructed and tested for these tractors in accordance with SAE J2194.

The ROPS testing included static and field

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## Agricultural Centers



The NIOSH sponsored agriculture safety and health research centers engage in research, intervention/prevention, and education/outreach projects designed to respond to regional priorities, investigate issues with potential worker safety/health impact, and document effectiveness of measures to reduce risks and prevent injuries and disease among the agricultural worker population.

### Other Tractor Safety Projects

**The Western Center** project related to tractor safety attempts to quantitatively validate the North American Guidelines for Children's Agricultural Tasks (NAGCAT) addressing the question: Can a 12 year old really do it (safely operate a tractor)? An evaluation of 250 tractors operated by children will be completed measuring basic dimensions/forces, fields of view, and entry/exit characteristics. This data will be used to identify potential anthropomorphic mismatches using the US data by Snyder (1997) and the University of Kentucky CHILDATA set.

**The Southwest Center** is analyzing data from two population-based studies (TX & LA) that each surveyed over 650 farmwomen about their work and injury experience, responsibilities, attitudes and behaviors toward tractor safety for themselves and for a sentinel child in the household. Five projects include tractor safety education – "One Seat: One Rider", PTO safety, and safe tractor operation including use of seatbelts and ROPS, as part of ongoing community-based activities.

**The Southern Coastal Center** is sponsoring the project "NC Farm Vehicle on Public Roads- Crash Danger and Safety Behavior" with additional funding from the NC Department of Labor. The project responds to the rapid influx of retirees into rural areas. Gold Star farmers participated in focus groups and identified crashes as the top issue of concern. Nearly 90% of these farms have warning lights and slow moving vehicle (SMV) signs on their farm equipment. Eighty-two per cent of Gold Star farms tractors are equipped with ROPS."

**The Midwest Center** is partnering with the University of Illinois to develop sensor technology to automate machinery alerts so that the operator may take corrective measures to prevent overturns, runovers, and rollovers.

**The Great Lakes Center** is engaged in a new study to enumerate ROPS-equipped tractors and farm/farmer characteristics in Central Ohio. The Center is also assisting with the implementation of 1) a new OH law regulating lighting and marking for tractors with dual wheels and 2) the ASAE standards work on a Speed Identification Symbol (SIS) for tractors traveling at 40 mph or less. Through leveraged funds, the Center is conducting a safe tractor and machinery operation certification program and tracking those who are certified as part of a national program.

## Partner Initiatives For Tractor Safety

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ROPS currently available for retro-fitting tractors have been tested to an array of regulations and standards. Lack of a single, universal standard makes it difficult for manufacturers to minimize production costs which would reduce costs to the consumer.

A new USDA agricultural safety and health research agenda has been developed from priority consensus of the land grant universities. The top five priorities are:

- 1) sensors and guarding systems,
- 2) ag equipment on public roads,
- 3) agricultural confined spaces,
- 4) emerging technologies,
- 5) human factors engineering and design. Project funding is available, on a competitive basis through Hazardous Occupations Training in Agriculture (HOSTA).

The State of Washington, Dept. of Labor OSHA plan requires employers to equip all pre-1976 model tractors with ROPS whether equipped when built or retro-fitted. The requirement does not apply to low-profile tractors when they are used in orchards, vineyards, hop yards, or inside buildings where the ROPS would be a hazard nor when the tractor is in use incidental to its primary function.

The National Institute for Farm Safety, Inc. is a leading North American organization of agricultural safety and health professionals. Members support shared educational resources, and have promoted standards for ROPS, hand signals, machinery lighting/marketing and guarding.

The National Education Center for Agricultural Safety (NECAS) is a partnership between the National Safety Council and Iowa Community College. The Center includes a tractor overturn demonstration area, various structures, and classrooms designed to address a host of agricultural hazards. Regular classes are offered for EMS providers, school children, farm families, and equipment operators.

Outside the United States, the state of Victoria, Australia has also launched a successful ROPS retrofit program which was reviewed at the conference.

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*Funds for this newsletter provided to the Southwest Center for Agricultural Health, Injury Prevention and Education by the National Institute for Occupational Safety and Health (Contract # 000025170)*

## ROPS Design For Older Tractors

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upset tests. The static test involved mounting the ROPS/frame combination on a hydraulic ROPS test stand. Field upset testing involved modifying the representative tractor operation for remote control and conducting rear and side-upset tests based on SAE J2194. Axle housing strength tests were conducted on these models to evaluate the suitability of the axle housing to support a ROPS.

The results from this study indicate ROPS can be successfully mounted to these four pre-ROPS tractors. Currently ROPS are being sold commercially for two of these pre-ROPS tractors.

## LOGGING IN VALUABLE RESOURCES



### WEBSITES

<http://cdc.gov/nasd> over 900 information items on tractor safety  
<http://nsc.org>  
<http://www.vafb.com/safety/farmtrac.htm>  
<http://kea.ae.iastate.edu/issue/1098>  
 Tractor safety for kids  
<http://safety.coafes.umn.edu/tractor/html>  
[http://www.fsai.on.ca/video\\_tractorsafety.shtml](http://www.fsai.on.ca/video_tractorsafety.shtml)  
<http://www.fs4jk.org/kidsmain.html>

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